PATENT
Docket No.: **201009/131**

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	:	Randy K. Young	Examiner: Freshteh N. Aghdam
Serial No.	:	09/765,712	Art Unit: 2611
Cnfrm. No.	:	2864	
Filed	:	January 19, 2001	
For	:	A BROADBAND MODULATION/DEMODULATION APPARATUS AND A METHOD THEREOF	

DECLARATION OF RANDY K. YOUNG UNDER 37 CFR § 1.132

Mail Stop:
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

I, Randy K. Young, declare:

1. I received a Ph. D. in Electrical Engineering from The Penn State University and a Masters of Electrical Engineering from the University of Southern California. I have worked my entire career in signal processing, systems and controls, and communications research and teaching.

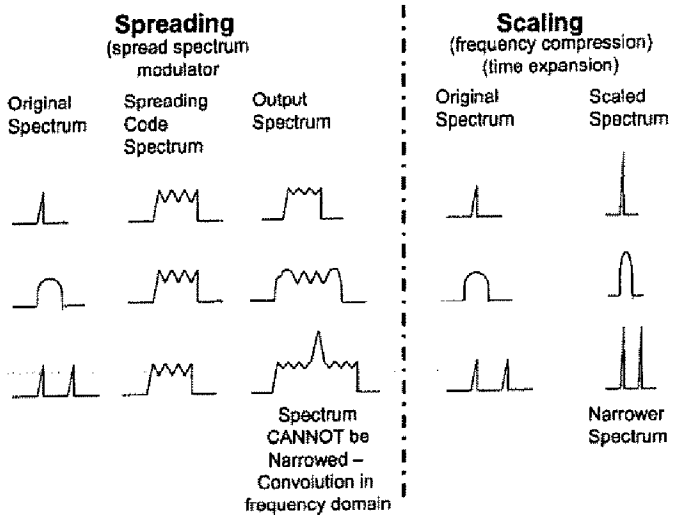
2. I am a Graduate Faculty Member in the Electrical Engineering Department and a Department Head at the Applied Research Laboratory at The Pennsylvania State University.

3. I am the sole inventor of the above-identified patent application.

4. Based on my review of U.S. Patent No. 5,859,870 to Tsujimoto (Tsujimoto), time-scaling can not be realized with the spread spectrum signal generators as disclosed in Tsujimoto. The spread spectrum signal generators disclosed in Tsujimoto are mixers/multipliers where the original signal is multiplied by a spreading code. The spread spectrum multiplying operation multiplies the original (or information bearing) signal with a "spreading code" signal. Thus, the operation is the multiplication of two signals: f(t) x(t). This functional multiplication operation causes the spectrum of the original signal to be

widened by at least the width of the spectrum of the spreading code. This functional mixing or multiplication operation can also shift the location of the spectrum in the frequency dimension; this shifting is sometimes referred to as translation.

5. Time-scaling implements the operation of *multiplying the independent variable of time; not multiplying the signal itself (as in mixing).* To demonstrate that time-scaling cannot be realized with a spread spectrum modulator, a time-expansion example is demonstrated here (as a counter-example to the assertion that time-scaling can be realized with a spread spectrum modulator). A two signal mixing or multiplication operation does not decrease the width of the original signal's spectrum; instead, this operation "spreads" the spectrum to a wider width. The typical spreading width of the resulting spectrum is approximately the summation of the width of both the original signal's spectrum added to the spreading code's spectral width. Alternatively, the time-scaling operation does not multiply the signal itself, only the independent variable of time, mapping x(t) to x(st), where "t" is the independent variable of time, and "s" is the time-scale. When the time-scale is less than one, $s<1$, then the time duration of x(st) will be greater than the duration of x(t); this is termed as a time expansion. Due to the duality of time and frequency, this time-scaling operation will result in the frequency spectrum, X(f), of x(t) being compressed according to X(f/s). Thus, a time expansion produces a frequency domain compression of the spectrum. This operation of continuous frequency compression cannot be realized with a spread spectrum modulator that spreads or extends the frequency content of the resulting signal (output of the multiplier). Thus, time-scaling cannot be realized with a spread spectrum modulator.



6. A Mathematical Explanation of the difference between spread spectrum and time scaling is set forth below: functional multiplication –versus- independent variable multiplication. It is impossible to realize the time-scaling operation with functional multiplication.

f(t)x(t)–versus- x(st), where f(t) is the spreading code and x(t) is the original signal. Fourier transform relationships and properties:

$$x(t) \leftrightarrow X(\omega)$$

$$x(st) \leftrightarrow \frac{1}{|s|} X(\frac{\omega}{s})$$

$$f(t)x(t) \leftrightarrow \int_{-\infty}^{\infty} X(\lambda)F(\omega-\lambda)d\lambda$$

For a particular frequency, ω1, frequency scaling by scale, (1/s), due to time expansion by a factor of s, will map ω1 to (ω1/s); thus, the change in frequency is [(1-(1/s)) ω1] or [(s -1) ω1]. The extent of the frequency shift or translation depends upon ω1, the absolute frequency. Additionally, since (s - 1) can be positive or negative, the frequencies can be shifted in either the positive or negative direction, leading to either expansion or compression relative to the spectral width of the original signal. From the aforementioned discussion of

the previous section, this time-scaling operation cannot be realized by spreading the spectrum further than the original spectrum.

7. Alternatively, functional multiplication results in convolution in the frequency domain. This frequency domain convolution effectively spreads the frequency content of each component of the original signal spectrum, $X(\omega)$, by the width of the "spreading signal spectrum," $F(\omega)$. Thus, each frequency of the original spectrum is spread by the same amount. This is contrary to frequency-scaling, where the extent of the frequency-shift or frequency-translation is dependent upon the particular frequency value. The spectral width of the resulting spectrum must be wider (spread) than the spectral width of the original signal. It cannot be narrower or compressed. Thus, time scaling cannot be realized with a spread spectrum signal generator as disclosed in Tsujimoto.

8 I hereby declare that all statements made herein of my own knowledge are true and that all statements made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Date: March 13, 2007

Randy K. Young

Randy K. Young